

AMENDMENTS TO THE CLAIMS:

Please cancel claims 1-23 without prejudice or disclaimer of the subject matter thereof and add new claims 24-44 as follows.

This listing of claims will replace all prior versions and listings of claims in the application:

1. – 23. (Canceled)

24. (New) An evaluation mask for evaluating a projection-type exposure apparatus, the mask comprising:

at least one diffraction grating pattern for producing a diffracted light of the positive first-order and a diffracted light of negative first-order, diffraction efficiencies of the diffracted lights being different respectively, one of the diffracted lights having a magnitude that is substantially zero, the at least one diffraction grating pattern being divided into eight regions, each of the regions includes a diffraction grating, and an image of the at least one diffraction grating pattern being projected onto a test substrate or an image detector by the projection-type exposure apparatus; and

a reference pattern for obtaining a reference image to measure a displacement of the image of the at least one diffraction grating pattern, and an image of the reference pattern being projected onto the test substrate or the image detector by the projection-type exposure apparatus,

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wherein the images of the at least one diffraction grating pattern and the reference pattern projected onto the test substrate or the image detector are used for evaluating the projection-type exposure apparatus.

25. (New) The evaluation mask according to claim 24, wherein the eight regions are divided into four groups, each of the groups comprises two adjacent diffraction gratings and the two adjacent diffraction gratings are oppositely directed.

26. (New) The evaluation mask according to claim 24, wherein
the reference pattern includes a diffraction grating pattern that is symmetrically relative to the at least one diffraction grating pattern.

27. (New) The evaluation mask according to claim 24, wherein
the reference pattern includes a first reference pattern and a second reference pattern and the at least one diffraction grating pattern is arranged between the first reference pattern and the second reference pattern.

28. (New) The evaluation mask according to claim 24, wherein
the at least one diffraction grating pattern include a first diffraction grating pattern and a second diffraction grating pattern, and the reference pattern is arranged between the first diffraction grating pattern and the second diffraction grating pattern.

29. (New) The evaluation mask according to claim 24, wherein
the at least one diffraction grating pattern include a first diffraction grating pattern and a second diffraction grating pattern, and the reference pattern includes a first reference pattern and a second reference pattern; and

the first diffraction grating pattern and the first reference pattern being arranged in parallel with each other on a first straight line, the second diffraction grating pattern and the second reference pattern being arranged in parallel with each other on a second straight line running perpendicular to the first straight line.

30. (New) The evaluation mask according to claim 24, further comprising:

a trim pattern; and

a part of a group of a line pattern which comprises the image of the at least one diffraction grating pattern being covered with an image of the trim pattern when the trim pattern and the diffraction grating pattern are exposed to light and images of the trim pattern and the at least one diffraction grating pattern are superposed.

31. (New) The evaluation mask according to claim 24, wherein

a plurality of pairs of the at least one diffraction grating pattern and the reference pattern are arranged rotationally at every 45° or 22.5°.

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32. (New) The evaluation mask according to claim 24, wherein
the at least one diffraction grating pattern includes a light-shield section for shielding
light and first and second transparent sections for transmitting light; and
an absolute value of the difference between a phase of light transmitted through the first
transparent section and a phase of light transmitted through the second transparent section being
different than 180° .

33. (New) The evaluation mask according to claim 32, wherein
the absolute value is equal to 90° .

34. (New) An evaluation mask according to claim 33, wherein
the ratio of the width of the light-shield section, the width of the first transparent section
and the width of the second transparent section is substantially 2 : 1 : 1.

35. (New) A focus measuring method for measuring a defocus of an image of a test
mark formed on a focus test mark projected on a substrate, the image being projected by a
projection-type exposure apparatus, the projection-type exposure apparatus projecting an image
of a mask pattern formed in a photo mask onto the substrate by way of a projection optical
system comprising:

preparing an evaluation mask as the focus test mark, the evaluation mask comprising: at
least one diffraction grating pattern for producing a diffracted light of the positive first-order and
a diffracted light of negative first-order, diffraction efficiencies of the diffracted lights being

different respectively, one of the diffracted lights having a magnitude that is substantially zero, and a reference pattern for obtaining a reference image to measure a displacement of an image of the at least one diffraction grating pattern,

preparing a substrate with a photo sensitizing material;

exposing the image of the at least one diffraction grating pattern and an image of the reference pattern onto the substrate simultaneously, the at least one diffraction grating pattern and the reference pattern comprising a test mark in the evaluation mask; and

measuring a relative distance of the image of the at least one diffraction grating pattern formed on the substrate and the image of the reference image formed on the substrate.

36. (New) The focus measuring method according to claim 35, wherein the at least one diffraction grating pattern being divided into eight regions, each of the regions includes a diffraction grating.

37. (New) The focus measuring method according to claim 36, wherein the eight regions are divided into four groups, each of the groups comprises two adjacent diffraction gratings and the two adjacent diffraction gratings are oppositely directed.

38. (New) The focus measuring method according to claim 35, wherein the reference pattern is a diffraction grating pattern that is symmetrically relative to the at least one diffraction grating pattern.

39. (New) The focus measuring method according to claim 35, wherein
the reference pattern includes a first reference pattern and a second reference pattern and
the at least one diffraction grating pattern is arranged between the first reference pattern and the
second reference pattern.

40. (New) The focus measuring method according to claim 35, wherein
the at least one diffraction grating pattern include a first diffraction grating pattern and a
second diffraction grating pattern and the reference pattern is arranged between the first
diffraction grating pattern and the second diffraction grating pattern.

41. (New) The focus measuring method according to claim 35, wherein
the at least one diffraction grating pattern include a first diffraction grating pattern and a
second diffraction grating pattern and the reference pattern includes a first reference pattern and
a second reference pattern; and

the first diffraction grating pattern and the first reference pattern being arranged in
parallel with each other on a first straight line, the second diffraction grating pattern and the
second reference pattern being arranged in parallel with each other on a second straight line
running perpendicular to the first straight line.

42. (New) An aberration measuring method for measuring an aberration of a projection-
type exposure apparatus based on a defocus of an image of a test mark formed on a focus test
mark projected on a substrate, the image being projected by the projection-type exposure

apparatus, the projection-type exposure apparatus projecting an image of a mask pattern formed in a photo mask onto the substrate by way of a projection optical system comprising:

preparing an evaluation mask as the focus test mark, the evaluation mask comprising: at least one diffraction grating pattern for producing a diffracted light of the positive first-order and a diffracted light of negative first-order, diffraction efficiencies of the diffracted lights being different respectively, one of the diffracted lights having a magnitude that is substantially zero, and a reference pattern for obtaining a reference image to measure a displacement of an image of the at least one diffraction grating pattern,

preparing a substrate with a photo sensitizing material;

exposing the image of the at least one diffraction grating pattern and an image of the reference pattern onto the substrate simultaneously, the at least one diffraction grating pattern and the reference pattern comprising a test mark in the evaluation mask under the condition of $\lambda / \{NA (1 - \sigma)\} \leq P \leq 2 \leq \lambda / \{NA (1 + \sigma)\}$, where σ is a partial coherence of a lighting optical system for lighting the test mark, P is a period of an image of a first pattern of the test mark, λ is the wavelength of light of the lighting optical system and NA is a numerical aperture of the projection optical system; and

measuring the relative distance of the image of the at least one diffraction grating pattern formed on the substrate and the image of the reference image formed on the substrate.

43. (New) The aberration measuring method according to claim 42, wherein the at least one diffraction grating pattern being divided into eight regions, each of the regions includes a diffraction grating.

44. (New) The aberration measuring method according to claim 42, wherein the eight regions are divided into four groups, each of the groups comprises two adjacent diffraction gratings and the two adjacent diffraction gratings are oppositely directed.

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